CONCEPTS FOR A TITAN ORGANICS EXPLORER

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ABSTRACT

This paper describes the results of a study of options for post-Cassini exploration of Titan as part of NASA's Pre-biotic Chemistry in the Outer Solar System campaign, conducted in cooperation with NASA's Solar System Exploration Subcommittee and its working groups. Both aerobot and rover missions for Titan in-situ explorations were considered. Additionally, an aerover mission, an innovative concept that combines global aerobot science with local rover science, was considered.

The science objectives are:

- To study distribution and composition of organics on Titan: in the atmosphere, on the surface, and below the surface.
- To study the role of geological and geophysical processes and evolution in Titan's prebiotic chemistry.
- To investigate the dynamics, meteorology, cloud formation, and interactions of Titan's atmosphere with its diverse surface.

The first mission studied was an aerobot mission. (As envisioned here, the term aerobot describes a balloon system that utilizes a condensable inflating fluid to control its altitude while drifting downwind.) A strawman payload was selected based on our current knowledge of Titan and instruments that are currently available or under development. Operationally, this is a global reconnaissance mission. Current knowledge of the winds leads us to expect that the aerobot could circle Titan every couple of weeks. The expected operational lifetime is about a month. The aerobot payload would continuously image and collect point spectra which it would use to decide where to sample. Simple radar would provide surface altimetry information. Samples would be collected by dropping a sampling device on a line and then reeling it in for analysis by a suite of instruments in the gondola. Wide- and narrow-angle imagery would be obtained of the sampling site. Both powered (steerable) and unpowered aerobots were considered.

The rover mission was assumed to have a surface range of several kilometers. The rover payload was a functional copy of the aerobot payload with seismometry and heat flow added. Sampling on the rover included the capability to collect 10-cm cores for analysis by the instruments. The rover could operate largely autonomously or could be directed from the ground as in the Pathfinder mission. There would also be the possibility of resampling if an analysis proved to be of particular interest. The rover lifetime would probably be several months.

The Aerover mission is a combination of the aerobot and rover missions that initially performs the aerobot mission and then performs a rover mission. It was suggested that this could be accomplished with an inflatable-wheeled rover by over-inflating the wheels to provide aerobot buoyancy. (This concept is considered immature relative to either a dedicated rover or a dedicated aerobot.) This system would be robust for a variety of surface conditions. We assumed a thirty day aerobot phase and then a thirty day rover phase.

All of the point design mission concepts use a six -year indirect solar electric propulsion (SEP) transfer trajectory from Earth to Saturn launching in 2008. Upon arrival at Saturn the orbiter and lander enter together directly into the atmosphere of Titan, where a ballute (a hypersonic drag device) decelerates the spacecraft. At appropriate velocity, the orbiter separates and the lander continues to decelerate for entry.

Cost estimates were marginally consistent with the scope of the Outer Planets program. At a first approximation, the aerobot, rover, and aerover concept s are equal in cost.